UNIVERSITY OF VICTORIA
FINAL EXAM
December 2015

Last Name: _____
First Name: _____
STUDENT NUMBER: V00_____

Course Name & Number	**Biology 355 - Evolution**
Section(s)	**A01**
CRN:	**10329**
Instructor:	**Geraldine Allen**
Duration:	**2 hr**

This exam has a total of 12 pages including this cover page.

Students must count the number of pages and report any discrepancy immediately to the Invigilator.

This exam is to be answered:

- On NCS Answer sheets
- In Booklets provided
- On the paper

PART A. MULTIPLE CHOICE QUESTIONS

(TO BE ANSWERED ON ANSWER SHEETS)

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1. An example illustrating evolutionary conflict between parent and offspring is:

    a. Begging behaviour by baby robins.
    b. Brood parasitism in cuckoos.
    c. Sibling aggression and siblicide in seabird nestlings.
    d. Adult offspring helping their parents with the current brood.
    e. Parental care by male seahorses.

2. Temperature-dependent sex determination (TSD) has evolved in:

    a. snakes
    b. marsupial mammals
    c. birds
    d. molluscs
    e. crocodiles

3. Diversifying natural selection:

    a. Is the main kind of natural selection described by Darwin
    b. Leads to a decrease in genetic variation of a population
    c. Is likely to change the mean value of a trait but not its variance
    d. May cause a population to diverge into two populations over time
    e. Is associated with a stable and uniform environment

4. A good example of adaptive phenotypic plasticity is:

    a. Left- and right-handedness in humans
    b. Variation in climbing ability of different species of anole lizards
    c. Wing colour polymorphism in butterflies
    d. Coat colour changes between summer and winter in arctic foxes
    e. Variation in beak size in Darwin's finches

5. Maleness and femaleness are fundamentally defined by:

    a. Morphological and physiological differences at reproductive maturity
    b. The presence of sex chromosomes
    c. The types of gametes produced
    d. The presence of mating strains
    e. Whether a mature individual lays eggs or not

6. Which of the following is not a life history trait?

   a. Age at sexual maturity
   b. Adult body size
   c. Age-specific fecundity
   d. Time to first reproduction
   e. Defenses against predation

7. Natural selection generally does not favour survival of individuals past reproductive age. However, such survival could be favoured when:

   a. a genotype that reproduces early in life has a shorter generation time than a genotype that reproduces later in life.
   b. postreproductive individuals provide care to their descendants.
   c. juvenile morality is high relative to adult mortality.
   d. there is a trade-off between early reproduction and adult survival.
   e. All of the above

8. What is the most likely explanation for the very low fecundity of species such as whales, humans, and elephants?

   a. Low probability of offspring survival
   b. Density-dependence
   c. High mobility
   d. High investment in parental care
   e. All of the above

9. Protogyny (hermaphroditism in which females switch to being males later in life) is favoured when:

   a. large individuals have higher fitness as males than as females.
   b. large individuals have higher fitness as females than as males.
   c. males prefer smaller females.
   d. a limited number of eggs reduces the number of times the organism can reproduce as a female.
   e. reproductive success is equal for males and females of any body size, but the organism prefers to mate as a male.

10. Mutation rates are expected to evolve toward very low levels, because:

   a. mutation has favoured inefficient repair enzymes.
   b. the repair system is highly efficient.
   c. natural selection acts against alleles that increase mutation rate, because most mutations are deleterious and recombination decouples them from beneficial mutants.
   d. mutations are not adaptations.
   e. populations experience deleterious mutations.

11. Which of the following is not a form of asexual reproduction?

    a. Budding
    b. Parthenogenesis
    c. Apomixis
    d. self-fertilization in hermaphrodites
    e. Vegetative propagation

12. What is meant by the "twofold" cost of sexual reproduction?

    a. Sexually reproducing species must produce male and female sex organs.
    b. Sexually reproducing species must find and attract mates.
    c. Sexually reproducing females must resist mating attempts and sperm entry.
    d. Assuming fecundity is the same in all females, sexually reproducing females will produce only half as many female offspring as asexually reproducing females.
    e. Sexually selected traits reduce survival.

13. What is the fundamental identifying feature indicating the presence of sexual selection?

    a. Variation in reproductive success is greater for one sex than for the other.
    b. The males are larger or showier than the females.
    c. The males have weapons of some kind but the females do not.
    d. The males produce large amounts of sperm and/or have elaborate mating behaviour.
    e. In any given reproductive period, a percentage of adults of reproductive age are not able to reproduce.

14. An action that decreases the fitness of the individual performing it but increases the fitness of another individual is an example of:

    a. Commensalism.
    b. Mutualism.
    c. Altruism.
    d. Cooperation.
    e. Self-interest.

15. In long-tailed manikins, subordinate male birds assist dominant male birds in coordinated mating displays. Which of the following explains the evolution of this behaviour?

    a. Females mate equally with subordinate and dominant males.
    b. Subordinate males take the place of dominant males when they die.
    c. The subordinate males mistake the dominant males for females.
    d. Subordinate males are always unrelated to dominant males.
    e. None of the above; there are no benefits to this behavior.

16. Cooperative behaviour may evolve because:

a. Individuals have higher survivorship when living in groups.
b. Individuals can learn fitness-enhancing skills (such as parenting) by helping other individuals.
c. It helps individuals to increase their indirect fitness.
d. Individuals can direct such behaviour towards others who will reciprocate.
e. All of the above.

17. Which of the following is most likely to favour the evolution of a highly virulent parasite?

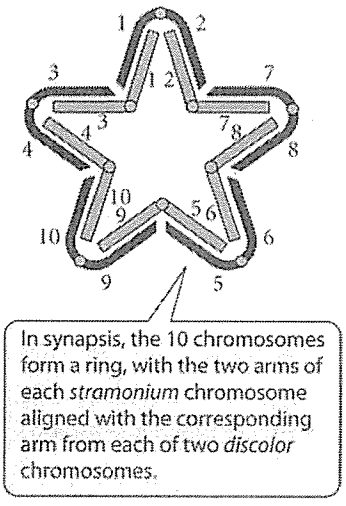
a. Horizontal transmission
b. Vertical transmission
c. Multilevel selection (both within and among populations of parasites in different hosts)
d. Small numbers of hosts
e. Mutualism between hosts and parasites

18. Which of the following ideas is central to the biological species concept?

a. Vicariance
b. Sexual selection
c. Divergent phenotypes
d. Reproductive isolation
e. Distinct lineages

19. Two species of jimsonweed (*Datura stramonium* and *D. discolor*) have genomes that differ by multiple reciprocal translocations, and F_1 hybrids of these two species have distinctive chromosomal pairings at meiosis (see diagram). This is an example of:

a. Hybrid vigour
b. A postzygotic reproductive barrier
c. A speciation event
d. Lack of correspondence between morphological differences and reproductive barriers
e. A hybrid zone



20. Allopatric speciation can be defined as:

    a. Evolution of reproductive isolation between spatially distinct populations that are connected via small amounts of gene flow.
    b. Divergence of a small population from a widely distributed ancestral form.
    c. Divergence, including the evolution of genetic reproductive barriers, between populations that are geographically separated.
    d. Evolution of genetic reproductive barriers within a single, initially panmictic population.
    e. Speciation resulting from divergence as indicated by DNA markers.

21. Why does reinforcement involve a strengthening of prezygotic, rather than postzygotic, reproductive barriers?

    a. The rewards of postzygotic isolation are always much smaller than those of prezygotic isolation.
    b. Reinforcement occurs only rarely.
    c. Posyzygotic isolation has only a minimal evolutionary impact.
    d. Individuals that avoid hybrid matings have a fitness advantage over individuals that produce hybrid offspring.
    e. Assortative mating is uncommon.

22. Most examples of speciation involving polyploidy occur in:

    a. plants.
    b. mammals.
    c. arthropods.
    d. prokaryotes.
    e. fungi.

23. What is one reason why it is difficult to measure speciation rates over evolutionary time scales?

    a. Speciation by polyploidy can be very rapid.
    b. High diversification rates in lineages can be due either to high rates of speciation or to low rates of extinction.
    c. Genetic variation among populations cannot be assessed in fossil groups.
    d. Generation times can be long.
    e. Ecological diversification contributes to speciation.

24. Coevolution between competing species may lead to:

    a. an evolutionary arms race.
    b. stable genetic equilibrium.
    c. indefinite fluctuations of genetic composition.
    d. extinction.
    e. ecological character displacement.

25. Suppose that you are in an area where cuckoos are known to occur, and you notice a mother bird pushing eggs out of its nest. What is the most likely explanation?

    a. The bird is sacrificing the eggs to distract the cuckoo birds from its other eggs.
    b. The mother bird does not want its offspring to be stolen by the cuckoo birds.
    c. The bird wants to have fewer offspring to reduce the effort involved with rearing them.
    d. The bird has recognized an attempt at brood parasitism and is removing the threat.
    e. Too many eggs attract cuckoo birds and the mother is reducing the threat.

26. In _____ mimicry, an unpalatable species mimics another unpalatable species to defend itself against a common predator and jointly reinforce avoidance by the predator.

    a. Darwinian
    b. simple
    c. Müllerian
    d. divergent
    e. Batesian

27. In species with males and females, sex ratios are typically 1:1. However, biased sex ratios might be expected in

    a. Species with eusociality.
    b. Species with sib mating, such as parasitoid wasps.
    c. Sequential hermaphrodites.
    d. Species with parthenogenetic reproduction.
    e. All of the above.

28. How do eukaryotic genes differ from the genes of bacteria and archaea?

    a. Bacterial and archaean genes are encoded by RNA, not DNA.
    b. Eukaryotic genes often are interrupted by introns.
    c. Eukaryotic genes are much smaller.
    d. Eukaryotic genes lack *cis*-regulatory elements.
    e. None of the above; eukaryotic genes do not differ from those of bacteria and archaea.

29. Which of the following hypotheses could explain how different genes can support different phylogenies?

    a. The varying of mutation rates across the genome
    b. The occurrence of horizontal gene transfer
    c. Variation of recombination rates across the genome
    d. Variation in effective population size among different species
    e. Alternative splicing of genes

30. What is the meaning of "subfunctionalization" in evolutionary molecular genetics?

    a. One of the gene duplicates retains its original function and the other acquires a new function.
    b. Each of a group of gene duplicates becomes specialized for a subset of the functions of the ancestral gene.
    c. One of the gene duplicates has degenerated to become a nonfunctional gene.
    d. A gene has pieces from two or more different ancestral genes.
    e. Splicing patterns are shared between gene duplicates.

31. A researcher studying the *Conus* genus of cone snails discovers that a single species is able to produce many dozens of slightly different variants of venom proteins, coded by closely related genes. What is the most likely explanation for this great variation?

    a. Hybridization between two snail species has left the offspring with multiple orthologous genes.
    b. Duplicated genes have undergone incomplete gene conversion, leading to many errors in sequence.
    c. Concerted evolution has resulted in the production of many venom genes scattered throughout the genome.
    d. Multiple gene duplication events have led to the production of a multigene family.
    e. The last common ancestor of all cone snails had a diverse set of venom genes that have been inherited by all cone snails.

32. Evolution can be constrained by several factors. Which of the following describes a *developmental* constraint?

    a. Limitations or biases in the production of phenotypes caused by the structure, character, or composition of how an organism is built.
    b. Limitations set by the genetic characteristics of the most recent common ancestor.
    c. Properties of biological material that prevent certain morphologies from being possible.
    d. A constraint preventing a trait from evolving because the trait is always disadvantageous.
    e. A constraint preventing certain evolutionary trajectories because of lack of genetic variation.

33. In flowering plants, the ABCE gene system produces transcription factors that control:

    a. Which branch tips will produce flowers.
    b. The differentiation of sepals, petals, stamens and carpels in relation to their position in the flower.
    c. The elongation rates of shoots.
    d. The production of male and female cones.
    e. The timing of flowering.

34. Which of the following methods is <u>not</u> used for characterizing gene expression patterns?

    a. In situ hybridization
    b. Northern blotting
    c. Reporter constructs
    d. Antibody staining
    e. Electron microscopy

35. In *Drosophila melanogaster,* insertion of genetic constructs containing the human *Pax6/eyeless* gene leads to the production of ectopic eyes. This demonstrates that:

    a. The *Pax6* gene arose multiple times.
    b. The *Pax6/eyeless* gene is conserved between vertebrates and invertebrates.
    c. Humans and fruit flies have a common ancestor in the recent (50 Mya) past.
    d. Alternative splicing drives phenotypic divergence in this example.
    e. The *Pax6* gene is not part of a developmental pathway.

36. Choose the correct answer. Microevolution involves _____, whereas macroevolution involves _____.

    a. processes that occur within species; evolution of higher taxa
    b. molecules; organisms
    c. genetic changes; phenotypic changes
    d. evolution of higher taxa; processes that occur within species
    e. organisms; ecosystems

37. The theory of punctuated equilibrium has been controversial because:

    a. it relies on data from the fossil record.
    b. it postulates that morphological evolution is accompanied by speciation.
    c. evolutionary stasis is rarely observed.
    d. different characters evolve at different rates.
    e. a combination of directional and balancing selection may be required for punctuated equilibrium to occur.

38. Richard Goldschmidt argued in 1940 that speciation occurred via systemic mutations, creating what he called "hopeful monsters". In modern terms, these could be explained by:

    a. Strong selection pressures occurring as populations diverge.
    b. The contribution of genetic drift in small populations.
    c. Chromosomal rearrangements during speciation.
    d. Mutations in Hox genes.
    e. Sexual selection.

39. Species concepts continue to be debated by evolutionary biologists because:

    a. No single concept fits all groups of organisms.
    b. Most species concepts cannot be applied to extinct species.
    c. Genetic and phenotypic traits often do not correspond.
    d. Species in many groups of organisms hybridize.
    e. All of the above are contributing factors in the debate.

40. In *The Origin of Species,* Darwin wrote: "That the eye, with all of its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection seems, I freely confess, absurd in the highest possible degree." How has this problem been resolved?

    a. It is still unresolved, and is a major weakness of Darwin's evolutionary theory.
    b. Evidence exists that complex eyes are a paedomorphic trait.
    c. Complex eyes evolved via large systemic mutations (as proposed by Richard Goldschmidt).
    d. Numerous examples of intermediate forms have been found, indicating that complex eyes can evolve via gradual change.
    e. The fossil record indicates that complex eyes are ancestral and simple eyes are derived.

PART B

(TO BE ANSWERED IN BOOKLETS)

I. (15 marks) Answer any **three** of the following questions (5 marks each).

1. List four kinds of evidence supporting the conclusion that the diverse forms of life on Earth have a common origin.

2. Hardy-Weinberg equilibrium describes the relationship between allele and genotype frequencies in a population undergoing no evolutionary change. What are the 5 assumptions of Hardy-Weinberg equilibrium?

3. It is easy to observe a trait and suggest that it is the result of natural selection; it is more difficult to provide good evidence. Suggest four types of evidence that could be used to indicate natural selection.

4. What is the difference between gene trees and species trees? How are they related?

5. Can group selection increase altruism? If so, under what circumstances? Discuss.

6. What is phenotypic plasticity? Is it adaptive or not? Explain, with examples.

II. (15 marks) Answer any **three** of the following questions (5 marks each).

1. Give an example of intergenomic conflict.

2. Dollo's law is a generalization which states that the evolutionary loss of complex characters is irreversible. Explain why this is the case.

3. What are four possible consequences of hybridization between two species?

4. How have transposable elements contributed to the evolution of eukaryote genomes? Discuss, wit examples..

5. What are Hox genes, and why was their discovery considered to be of such great evolutionary importance?

6. What is meant by iteroparous and semelparous life histories? Under what conditions would each of these be favoured by natural selection?

III. (10 marks) Answer **one** of the following questions (10 marks).

1. Describe three species concepts that are in common use, explaining their strengths and weaknesses.

2. Individuals of many species in different lineages are brightly coloured and conspicuous (at least to human eyes). What are the possible evolutionary explanations for this? Explain, using examples from different groups.

3. What are four mechanisms that give rise to new genes? Explain.

END